

## CLAIMS

1. A method of evaluating a cell state based on information of an image taken of a cell containing a chromosome territory, the method comprising:

extracting said chromosome territory from said image;  
5 standardizing a positioning state of said chromosome territory and then quantifying said positioning state; and  
evaluating said cell state based on the quantified positioning state of said chromosome territory.

2. The evaluation method as set forth in Claim 1, wherein in said chromosome territory extraction, in addition to extracting a nucleus of said cell, said chromosome territory contained in said nucleus is extracted, and

5 said positioning state quantification comprises standardizing a form of said nucleus and transforming coordinates of said chromosome territory based on a change in form between said nucleus before standardization and said nucleus after standardization.

3. The evaluation method as set forth in Claim 1 or Claim 2, the method further comprising:

statistically processing a quantification result of said positioning state of a plurality of cells,  
5 wherein in said cell state evaluation, a state of a single cell is evaluated based on a result of quantifying said positioning

state of said single cell and a result of said statistical processing.

4. The evaluation method as set forth in Claim 3,

wherein said statistical processing comprises calculating a standard value of a quantification result of said positioning state based on a result of quantifying said positioning state of a plurality

5 of cells, and

in said cell state evaluation, a state of a single cell is evaluated based on a result of quantifying said positioning state of said single cell and said standard value.

5. A method of evaluating a cell state based on information of an image taken of a cell containing a chromosome territory, the method comprising:

5 extracting a plurality of chromosome territories from said image;

quantifying a positioning state of said plurality of chromosome territories;

statistically processing results of quantifying said positioning state of a plurality of cells; and

10 evaluating a state of a single cell based on a result of quantifying said positioning state of said single cell and a result of said statistical processing.

6. The evaluation method as set forth in Claim 5,

wherein said positioning state comprises at least one of a distance between said plurality of chromosome territories and a

positioning direction of said plurality of chromosome territories.

7. The evaluation method as set forth in Claim 5 or 6,  
wherein said quantifying comprises calculating a distance  
between said plurality of chromosome territories.

8. The evaluation method as set forth in Claim 7,  
wherein said distance calculation comprises:  
calculating a center of gravity of each of said plurality of  
chromosome territories; and

5 calculating a distance between said centers of gravity.

9. The evaluation method as set forth in any one of Claims 5 to  
8,  
wherein said quantifying comprises quantifying the  
positioning direction of said plurality of chromosome territories.

10. The evaluation method as set forth in Claim 9,  
wherein said positioning direction quantification comprises:  
detecting a principal axis of each of said plurality of  
chromosome territories; and

5 calculating an angle of said principal axis.

11. A method of evaluating a cell state based on information of  
an image taken of a cell containing a chromosome territory, the method  
comprising:

extracting from said image each of a nucleus of said cell and

5 the chromosome territory;

quantifying a positioning state of said nucleus and said chromosome territory;

statistically processing results of quantifying said positioning state of a plurality of cells; and

10 evaluating a state of a single cell based on a result of quantifying said positioning state of said single cell and a result of said statistical processing.

12. The evaluation method as set forth in Claim 11,

wherein said quantifying comprises calculating a distance between a reference point within said nucleus and said chromosome territory.

13. The evaluation method as set forth in any one of Claims 5 to 12,

wherein said positioning state quantification of said chromosome territory further comprises standardizing a positioning  
5 state of said chromosome territory, and after standardizing the positioning state of said chromosome territory, quantifying said positioning state.

14. The evaluation method as set forth in Claim 13,

wherein said statistical processing comprises calculating a standard value of a quantification result of said positioning state based on a result of quantifying said positioning state of a plurality  
5 of cells; and

in said cell state evaluation, a state of a single cell is evaluated based on a result of quantifying said positioning state of said single cell and said standard value.

15. The evaluation method as set forth in any one of Claims 1 to 14,

wherein said positioning state comprises at least one of a relative position of said chromosome territory within a nucleus of said cell, a direction of a principal axis of said chromosome territory, and a spread of said chromosome territory.

16. The evaluation method as set forth in any one of Claims 1 to 15,

wherein said image is formed from a plurality of pixels each having an attribute value;

5 said chromosome territory extraction comprises:

classifying said image into a plurality of classes; and

extracting any of said classes from said image as a region representing said chromosome territory, and

said classifying comprises:

10 setting an initial value for an attribute parameter indicating an attribute value of each of said classes and for a mixture ratio of each of said classes;

calculating based on said attribute parameter and said mixture ratio a class membership probability of each of said plurality of pixels being classified into each of said classes;

calculating an evaluation function which represents a

goodness of estimation based on said membership probability and a mixture probability distribution defined by said attribute parameter and said mixture ratio and determining whether or not said evaluation  
20 function satisfies predetermined conditions;

updating said attribute parameter and said mixture ratio when said evaluation function does not satisfy said predetermined conditions; and

classifying said plurality of pixels into any of said  
25 plurality of classes based on said attribute parameter and said mixture ratio when said evaluation function satisfies said predetermined conditions.

17. The evaluation method as set forth in Claim 16,  
wherein said class membership probability calculation comprises:

decomposing said plurality of pixels into a plurality of  
5 partial spaces according to the attribute value of said pixels;

calculating a coarse-grained empirical probability distribution representing a proportion of pixels contained in said partial space; and

calculating based on said attribute parameter and said mixture  
10 ratio a coarse-grained class membership probability of each of said partial spaces being classified into each of said classes; and

said evaluation function calculation comprises calculating a coarse-grained mixture probability distribution by averaging, within said partial space, mixture probability distributions defined  
15 by said attribute parameter and said mixture ratio, said evaluation

function being calculated based on said coarse-grained empirical probability distribution, said coarse-grained mixture probability distribution, and said coarse-grained class membership probability.

18. A system for evaluating a cell state based on information of an image taken of a cell containing a chromosome territory, the system comprising:

an extraction processing unit which extracts said chromosome  
5 territory from said image;

a quantification processing unit which quantifies a positioning state of said chromosome territory that has been extracted;

a memory unit which stores a result of quantifying said  
10 positioning state;

a statistical processing unit which statistically processes a result of quantifying said positioning state of a plurality of cells; and

an evaluating unit which evaluates a state of a single cell  
15 based on a result of quantifying said positioning state of said single cell and a result of said statistical processing.

19. The evaluation system as set forth in Claim 18,

wherein said quantification processing unit standardizes the positioning state of said chromosome territory extracted from said image and, after standardizing the positioning state of said  
5 chromosome territory, quantifies said positioning state.

20. The evaluation system as set forth in Claim 19,

wherein said extraction processing unit extracts a nucleus of said cell and also extracts said chromosome territory contained in said nucleus, and

5        said quantification processing unit standardizes a form of said nucleus and transforms coordinates of said chromosome territory based on a change in form between said nucleus before standardization and said nucleus after standardization.

21. A program which, in a computer, evaluates a cell state based on information of an image taken of a cell containing a chromosome territory, the program making the computer function as:

5        a unit which extracts said chromosome territory from said image;

      a unit which standardizes a positioning state of said chromosome territory and then quantifies said positioning state; and

10       a unit which evaluates said cell state based on the quantified positioning state of said chromosome territory.

22. A program which, in a computer, evaluates a cell state based on information of an image taken of a cell containing a chromosome territory, the program making the computer function as:

5        an extracting unit which extracts said chromosome territory from said image;

      a quantifying unit which quantifies a positioning state of said chromosome territory that has been extracted;



a memory unit which stores a result of quantifying said positioning state;

10        a statistical processing unit which statistically processes a result of quantifying said positioning state of a plurality of cells; and

an evaluating unit which evaluates a state of a single cell based on a result of quantifying said positioning state of said single  
15 cell and a result of said statistical processing.